Months.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	Totals.	Annual mean.
January	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
February	0	0	0	0	1	1	0	1	1	0	0	0	0	0	4	0.29
March	1	1	0	1	0	0	1	2	1	0	1	0	0	0	8	0.57
April	2	1	0	2	1	3	3	2	4	0	2	2	3	3	28	2.00
May	3	3	0	5	5	5	2	4	2	3	3	5	2	8	50	3.57
June	7	3	4	3	4	8	6	6	3	10	5	7	10	2	78	5.57
July	9	8	5	8	10	4	3	2	4	11	8	10	7	9	98	7.00
August	4	5	9	2	12	3	3	6	6	8	5	5	7	9	84	6.00
September	2	6	0	4	2	2	1	5	2	2	2	3	4	4	39	2.79
October	0	0	1	0	1	2	2	1	0	1	0	0	0	0	8	0.57
November	0	0	0	2	0	0	0	0	0	0	0	0	1	0	3	0.22
December	1	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0.14
Annual	29	27	19	27	36	28	21	30	23	35	27	32	34	35	402	28.7

This table apparently gives us a close approximation to the normal distribution of thunderstorm days in that locality. It will be noticed that we have here not the number of storms, but the number of days on which one or more storms occurred. The record does not include thunderstorms at an indefinitely great distance, but only those that were near enough to give audible thunder, and this rarely occurs when the storm is more than 10 miles distant; in fact a distance of 3 miles would appear to be a fair average for the storms here recorded.

The months in which thunderstorm days were most numerous were: August, 1887, 12; July, 1892, 11; July, 1887, June, 1892, July, 1894, June, 1895, 10. The average number for July was 7, and the average number for the whole year, 29. The maximum was 36 in 1887.

AUDIBILITY OF THUNDER.

The audibility of thunder depends not merely on the initial intensity of the crash, but equally on the surroundings of the observer, since in the quiet country one will observe feeble sounds that escape the ear in a noisy city. But perhaps the most curious and important condition of audibility is that the thunder, or wave of sound, shall not be refracted or reflected by the layers of warm and cold air between the observer and the lightning or by the layers of wind, swift above and slow below, so as to entirely pass over or around the observer. Sound is somewhat analogous to a wave phenomenon, and consequently is subject to refraction when it passes obliquely through layers of air of different densities. Such refraction may occur at any time and place. Thus observers at the topmast of a ship frequently hear fog whistles that are inaudible at sea level; those on hilltops hear thunder that is inaudible in the valley; those in front of an obstacle hear sounds inaudible to those behind it. The rolling of thunder, like that of a distant cannonade, may be largely due to special reflections and refractions of sound. Again, the greater velocity of the air at considerable altitudes above the ground distorts the sound wave and shortens the limit of audibility to the leeward, but increases it to the windward. In this way it happens that the thunder from very distant storms rarely reaches the ear. Lightning may be seen and its illumination of clouds and mist may be recognized when it is even 200 miles distant, but thunder is rarely audible 10 miles. Hence we see the need of a large number of stations if we would catch the record of every thunderstorm that happens. Probably one for every 25 square miles would not be too many. On the other hand, a few stations would suffice, at least for the nighttime, if each should report the direction and movement of every case of distant lightning.

MOVEMENTS OF WINDS AND CLOUDS IN MINNESOTA.

Mr. O. F. Rice, of Pine Island, Minn., inquires "why storm clouds appear so often on our west and winds come so constantly from the southern directions?"

As this very general question was penned in July, the Editor thinks it likely that Mr. Rice had in mind the southerly winds of the summer season in Minnesota, for the question can hardly refer to the average winds of the whole year, since in the winter time these come from the north or northwest. If one studies carefully the charts of resultant winds published regularly on Chart No. IV of the MONTHLY WEATHER REVIEW, he will perceive that in passing from the summer to the winter and *vice versa*, a gradual change takes place, not only in the direction of the winds, but also in the distribution of the temperature and barometric pressure of the lower atmosphere. These observations although made at the surface of the earth give us reason to believe that the average temperature of the mass of air above Minnesota, Manitoba, and the neighboring region is in summer much warmer than over the country to the westward of the Rocky Mountains. It will also be noticed that the barometric pressure in this central portion of the continent is, in the summer time, lower than on the Pacific Coast to the westward, and especially lower than on the Atlantic Coast to the south and east. The winds move in obedience to the differences of pressure prevailing in the neighborhood of the station. These differences may be due either to differences of temperature—by reason of which cold, dense air underflows and raises up warmer, light air—or they may be due to the differences of pressure at any level by reason of which regions of great pressure push their air into the regions of low pressure. Both of these causes are usually active in the free atmosphere, and doubtless the southerly winds of Minnesota represent the resultant effect of the general distribution of pressure and temperature in North America—not only at the surface of the ground but in the free air above the ground.

If we ascend through the lower atmosphere and study the motions of the upper air as shown by the clouds, we find a general rapid movement from west to east or southwest to northeast, showing that the motions of the upper air are largely controlled by the pressures and temperatures prevailing at the upper level. In general, a certain definite mass of air tends to flow down a gentle slope toward the region where the density of the air is less than its own at the same height above sea level. As soon as the motion begins the influence of the rapid diurnal whirl of the earth on its axis is felt by the moving air so that the upper layers above Minnesota move nearly from west to east while the lowest layer at the surface moves from the south or southwest to northeast. Therefore, while the upper clouds and the storms that they attend come from the west the lowest winds are blowing from the south.

In the winter time the distribution of temperature and pressure over North America is such as to force the cold air of Canada southward over Minnesota. The upper layers move more nearly from the west, while the lowest layers come more nearly from the north, so that at the surface of the earth northerly winds are more frequent; consequently, in the winter we do not have southerly winds below and westerly winds above, except on those dates when low pressure prevails in Canada analogous to the low pressures of the summer season.

HOURLY RESULTS FROM SELF-REGISTERS.

The Weather Bureau maintains self-registers for pressure, temperature, wind direction, rainfall, and sunshine at a very large proportion of its stations, and for the wind velocity at all of them, and the general results are given monthly in the elaborate climatological tables contributed by Mr. A. J. Henry, Chief of the Records Division. In continuation of this work Mr. Henry has prepared, for the forthcoming Annual Report of the Chief of the Weather Bureau for the year 1896, extended tables of the hourly, monthly, and seasonal mean values, the resultant winds, and other climatological data for a selected group of about 28 stations; as an abstract of this more elaborate work the Editor has, with his permission, compiled the accompanying tables on pages 254–256.

Tables 1, 2, and 3 give, respectively, the mean pressure, temperature, and velocity of the wind for each hour of the day for the five years 1891–95, inclusive. The figures in Table 1 were deduced from the records of the Richard aneroid barographs. These registers are checked by at least two comparative readings daily of the mercurial barometers at the respective stations. They are, therefore, at least approximately corrected for the diurnal and for the non-periodic fluctuations in the temperature of the aneroid. These fluctuations of instrumental temperature, as is well known, affect the records of the aneroid quite appreciably, but it is not likely that an outstanding error of 0.01 inch has been thereby introduced into these 5-year means. The pressures thus given, as measured in inches of the mercurial barometer, are the so-called "apparent pressures," and, in order to obtain standard pressures, according to the accepted common sense rule of physicists and meteorologists, they still need a correction for the local value of gravity, or the so-called reduction to standard gravity. These corrections are given in the last column of Table 1; they have been determined by using the values of local gravity, given in Table 7, which were computed by the use of Helmert's formula. (See MONTHLY WEATHER REVIEW, 1896, p. 463.) According to Mr. G. R. Putnam, of the Coast and Geodetic Survey, this formula represents the force of gravity at any locality and altitude in the United States to within 0.0002 of its value. Helmert's formula represents the force of gravity at a given elevation above the sea without regarding any possible local peculiarities of topography. Owing to these latter the values of the computed gravity may be in error by three units in the first decimal or 0.0003 of the full value of gravity in an extreme case, and it is therefore desirable to use the observed forces of gravity at each station instead of these computed approximations. Although our mean apparent atmospheric pressures are given to the nearest thousandth of an inch, yet the resulting standard pressures can only be considered reliable to the nearest hundredth of an inch on account of the outstanding uncertainty in our knowledge of the local force of gravity. The reduction to standard gravity in Table 4 differs but little from the reduction for 30 inches of mercury at sea level.

Whenever changes in the location of the station, affecting barometric pressures, have been made during these five years, the records have all been reduced uniformly to the elevation of the barometer above mean sea level that obtained on December 31, 1895, and these elevations are those given in Table 7.

The temperatures recorded by the Richard thermographs have been reduced to standard temperatures within the instrument shelter in which the thermograph is placed by two or more daily readings of the standard whirled thermometer. These standard thermometers rarely have errors exceeding 0.3° F. at any part of their scales, and as the positive and negative corrections are eliminated in the mean of the 150 readings on which each of these printed numbers depends, the temperatures may be considered as standard for the interiors of the shelters and for the respective altitudes above ground. As the shelters are single "jalousies," allowing the wind free entrance, it is believed that only in exceptional cases, such as absolute calm in sunshine, can the temperature of the thermometer differ from that of the outside free air by more than 0.5° F.

The altitudes of the thermometers above ground are given for December 31, 1895, in Table 7. In a number of cases the altitudes at that date are considerably higher than in the previous years, and especially is this the case in large cities where the growing tendency to erect tall buildings has necessitated the removal of the local Weather Bureau station to the top of the tallest building, in order that our signal flags may be placed most advantageously. For the same reason, therefore, there has been a steady upward movement of anemometers and rain-gauges. But, as these tall buildings are also large, the influence of the building itself becomes quite appreciable, and one should consider the height of the instruments above the roof in connection with the height above ground; it is not practicable at present to answer the complex question as to what may be the exact nature and amount of the reduction of a temperature, wind velocity, or rainfall from these elevated stations down to the standard exposure near the surface of the open ground. Undoubtedly on our elevated buildings the temperatures are slightly lower, the rain-catch considerably smaller and the wind velocity frequently larger than for stations at the surface of the ground, but comparison with other stations shows that the differences do not seem to be so large as has often been feared. So far as temperature is concerned it is much more difficult to determine the true temperature of the air near the ground than at the top of a tall building, because at the ground the wind is much diminished and is liable to bring special streaks of hot or cold air, therefore the observer must whirl his thermometers more rapidly and for a longer period in order to get the average temperature; at the higher level, the special streaks of hot and cold air have all merged into one homogeneous mass, and the strength of the wind facilitates the ventilation of the thermometer shelter, and therefore the rapidity with which the thermometer bulb follows the temperature of the air. From this latter point of view the internal sensitiveness of the thermometer is a matter of prime importance; the coefficient of sensitiveness (see Treatise on Meteorological Apparatus p. 71) is quite small in Weather Bureau thermometers, so that if the bulb is 5° above the temperature of the air it will fall to that temperature in less than two minutes, under steady ventilation. Undoubtedly the maximum temperatures in an elevated shelter will be lower and the minimum temperatures higher than those in a ground shelter; it is this difference that makes the ground shelter so especially local in its character. It is often said that for biological studies a climatologist needs temperatures nearer the surface of the ground than are given by the elevated shelters of the Weather Bureau, but the case ought to be put more strongly than this, since in biology and in hygiene one should have the temperatures at the spot where the plant or the man is, and, therefore, special observations must be made by these students in the localities that interest them. In a general way, the average temperature at any small altitude above the earth surface may be reduced to that at a standard elevation of 5 feet above the surface, provided the wind is blowing strongly at both places, by adopting the adiabatic law of cooling, viz, 1° C., per 100 meters, or 1° F. per 182.3 feet. When the wind is not blowing, as in the early morning hours, and when the lower station is in a special layer of cold air, this rule is entirely changed, and radiation and conduction become the important factors. Therefore, a reduction to standard altitude above ground can only be rationally applied to the average of the whole twenty-four hours, or of the year, and this reduction, calculated for the rate just given, will be found in the last column but one of Table 3.

The reduction of temperatures to sea level, like the reduction of pressure to sea level, is a process encumbered with several hypotheses, and the Editor considers it wiser to reduce such observations as are made at continental stations to some upper level representing the real atmosphere, in whose phe-

TABLE 1.—*Mean local pressure at each hour of seventy-fifth meridian time.*

Stations.	1 a.m.	2 a.m.	3 a.m.	4 a.m.	5 a.m.	6 a.m.	7 a.m.	8 a.m.	9 a.m.	10 a.m.	11 a.m.	Noon.	1 p.m.	2 p.m.	3 p.m.	4 p.m.	5 p.m.	6 p.m.	7 p.m.	8 p.m.	9 p.m.	10 p.m.	11 p.m.	Midnight.	Daily mean.	Reduction to standard gravity.
Bismarck, N. Dak	28.187	.186	.186	.186	.186	.188	.192	.195	.199	.200	.199	.197	.187	.176	.165	.159	.158	.158	.161	.165	.172	.179	.184	.186	28.181	+0.000
Boston, Mass	29.885	.884	.882	.882	.888	.894	.902	.907	.906	.908	.894	.881	.869	.862	.859	.860	.865	.871	.879	.884	.890	.891	.890	.888	29.884	−0.008
Buffalo, N. Y	29.266	.263	.262	.261	.265	.271	.280	.286	.290	.291	.288	.279	.268	.259	.254	.252	.253	.256	.261	.266	.270	.272	.271	.270	29.269	−0.008
Chicago, Ill	29.139	.137	.137	.136	.137	.142	.148	.156	.160	.162	.163	.158	.146	.134	.126	.122	.121	.122	.126	.130	.136	.141	.142	.142	24.140	−0.010
Cincinnati, Ohio	29.393	.391	.391	.392	.395	.404	.413	.420	.426	.427	.425	.415	.398	.383	.372	.366	.365	.367	.373	.378	.387	.392	.394	.395	29.394	−0.017
Cleveland, Ohio	29.236	.236	.237	.239	.244	.251	.259	.265	.269	.269	.267	.258	.245	.233	.226	.222	.222	.224	.229	.233	.235	.237	.237	.337	29.242	−0.012
Detroit, Mich	20.244	.242	.242	.242	.244	.249	.257	.263	.267	.268	.266	.258	.245	.234	.227	.224	.224	.226	.231	.237	.243	.246	.246	.246	29.245	−0.010
Dodge City, Kans	27.405	.402	.399	.397	.396	.397	.403	.411	.421	.428	.432	.432	.421	.408	.385	.373	.366	.362	.364	.370	.380	.391	.400	.404	27.398	−0.024
Eastport, Me	29.882	.880	.879	.880	.885	.892	.900	.906	.910	.908	.899	.888	.878	.872	.869	.868	.870	.874	.878	.882	.886	.886	.886	.884	29.885	−0.000
Galveston, Tex	30.036	.032	.027	.025	.025	.030	.040	.051	.063	.072	.077	.074	.060	.042	.027	.015	.009	.007	.009	.016	.024	.034	.039	.039	30.036	−0.042
Havre, Mont	27.329	.329	.329	.327	.327	.326	.3.7	.329	.334	.340	.344	.346	.342	.332	.321	.311	.305	.302	.300	.299	.305	.313	.321	.326	27.324	+0.003
Key West, Fla	30.056	.046	.037	.034	.036	.044	.058	.070	.080	.085	.084	.074	.058	.042	.029	.019	.019	.025	.035	.051	.060	.066	.067	.063	30.052	−0.051
Marquette, Mich	29.158	.157	.157	.156	.157	.159	.165	.169	.170	.172	.173	.171	.163	.156	.151	.151	.153	.154	.156	.158	.161	.162	.162	.161	29.160	+0.002
Memphis, Tenn	29.660	.658	.657	.658	.660	.668	.679	.690	.700	.706	.709	.703	.686	.667	.651	.641	.636	.634	.638	.643	.652	.659	.662	.662	29.666	−0.028
New Orleans, La	30.024	.019	.015	.014	.017	.025	.036	.045	.056	.062	.062	.055	.038	.020	.005	.996*	.992	.993	.999	.006†	.017	.026	.029	.027	30.024	−0.040
New York, N. Y	29.721	.719	.716	.714	.717	.724	.732	.738	.740	.739	.732	.721	.708	.698	.692	.691	.693	.698	.704	.712	.719	.723	.725	.724	29.717	−0.013
Philadelphia, Pa	29.936	.934	.933	.933	.937	.944	.954	.962	.965	.965	.958	.944	.929	.918	.911	.908	.910	.915	.923	.931	.938	.941	.941	.940	29.936	−0.014
Pittsburg, Pa	29.158	.157	.157	.158	.161	.168	.175	.181	.183	.181	.176	.165	.151	.138	.130	.127	.128	.132	.139	.147	.152	.155	.157	.158	29.156	−0.015
Portland, Oreg	29.892	.894	.896	.896	.897	.898	.897	.897	.900	.904	.908	.912	.914	.912	.902	.892	.882	.875	.869	.865	.867	.872	.879	.887	29.892	+0.001
St. Louis, Mo	29.444	.442	.442	.442	.444	.450	.459	.468	.474	.478	.479	.474	.459	.443	.429	.421	.417	.417	.420	.425	.433	.440	.444	.445	29.444	−0.018
St. Paul, Minn	29.094	.093	.093	.094	.095	.098	.103	.106	.111	.113	.113	.110	.099	.087	.076	.071	.071	.068	.070	.074	.080	.087	.091	.093	29.091	−0.002
Salt Lake City, Utah	25.662	.664	.663	.663	.664	.664	.667	.672	.679	.686	.691	.695	.692	.683	.669	.657	.649	.643	.639	.639	.642	.648	.654	.660	25.664	−0.018
San Diego, Cal	29.949	.948	.944	.939	.933	.928	.927	.929	.938	.949	.958	.964	.966	.960	.947	.934	.925	.920	.917	.917	.923	.931	.940	.946	29.939	−0.033
San Francisco, Cal	29.901	.902	.901	.899	.896	.893	.891	.893	.900	.909	.918	.925	.930	.928	.917	.905	.894	.886	.880	.875	.877	.881	.880	.897	29.899	−0.020
Santa Fe, N. Mex	23.295	.296	.295	.294	.292	.291	.292	.297	.303	.309	.314	.318	.315	.304	.289	.278	.268	.263	.261	.263	.268	.277	.286	.293	23.290	−0.035
Savannah, Ga	29.994	.990	.987	.987	.992	.002	.014	.024	.031	.034	.029	.015	.995	.978	.966	.961	.962	.968	.977	.987	.995	.000	.001	.998	29.995	−0.035
Washington, D. C	29.956	.953	.952	.952	.956	.964	.973	.981	.986	.989	.985	.971	.956	.941	.933	.928	.929	.934	.941	.949	.957	.960	.960	.059	29.957	−0.016

*29.996. †30.006.

TABLE 2.—*Mean local temperature at each hour of seventy-fifth meridian time.*

Stations.	1 a.m.	2 a.m.	3 a.m.	4 a.m.	5 a.m.	6 a.m.	7 a.m.	8 a.m.	9 a.m.	10 a.m.	11 a.m.	Noon.	1 p.m.	2 p.m.	3 p.m.	4 p.m.	5 p.m.	6 p.m.	7 p.m.	8 p.m.	9 p.m.	10 p.m.	11 p.m.	Midnight.	Daily mean.	Reduction from shelter to ground.	Reduction from ground to sea level.
Bismarck	36.4	35.5	34.8	34.0	33.2	32.6	32.2	33.0	34.4	37.0	40.0	42.7	45.0	46.8	48.1	48.9	49.0	48.3	46.7	44.7	42.3	40.2	38.7	37.4	40.1	0.09	3.34
Boston	46.3	45.9	45.5	45.1	44.8	44.9	45.8	47.4	48.9	50.4	51.8	53.0	53.7	54.1	54.0	53.5	52.9	52.0	50.7	49.7	48.8	48.1	47.4	46.9	49.2	0.63	0.03
Buffalo	45.7	45.3	45.0	44.6	44.3	44.4	44.8	45.9	46.9	48.0	49.1	50.0	50.6	51.0	51.3	51.2	50.8	50.0	49.2	48.3	47.6	47.1	46.5	46.2	47.7	0.57	1.21
Chicago	46.5	46.0	45.5	45.0	44.6	44.2	44.2	44.9	45.9	47.1	48.1	49.1	49.8	50.4	50.8	51.1	51.1	50.7	50.0	49.3	48.6	48.1	47.5	47.0	47.7	1.32	1.19
Cincinnati	52.0	51.3	50.5	49.9	49.2	48.6	48.6	49.4	51.1	53.1	55.1	56.9	58.3	59.2	60.0	60.4	60.4	59.9	58.9	57.6	56.3	55.1	54.0	52.9	54.5	0.84	1.11
Cleveland	47.0	46.5	46.0	45.6	45.2	44.9	45.2	46.8	48.2	49.8	51.0	52.0	52.6	53.0	53.2	53.3	53.2	52.8	52.0	51.0	50.1	49.2	48.4	47.7	49.4	0.67	1.30
Detroit	45.1	44.7	44.3	43.8	43.4	43.1	43.4	44.7	46.2	48.0	49.7	51.0	52.1	52.9	53.4	53.4	52.9	52.1	50.8	49.4	48.3	47.4	46.6	45.9	48.0	0.87	1.20
Dodge City	48.0	47.2	46.3	45.5	44.7	44.0	43.3	44.2	46.2	49.6	53.7	56.9	59.9	61.9	63.4	64.2	64.3	63.4	61.1	57.3	54.4	52.3	50.6	49.2	53.0	0.24	4.97
Eastport	39.4	39.0	38.7	38.4	38.3	38.7	39.5	40.7	42.0	43.2	44.3	45.1	45.7	46.0	45.9	45.5	44.7	43.7	42.7	42.0	41.4	40.8	40.3	30.8	41.9	0.38	0.08
Galveston	68.4	68.2	67.9	67.6	67.4	67.1	66.9	67.2	67.7	68.5	69.4	70.2	70.8	71.2	71.5	71.5	71.4	71.0	70.4	69.8	69.5	69.2	68.9	68.7	69.2	0.47	0.01
Havre	37.4	36.5	35.7	34.9	34.1	33.4	32.9	33.3	34.7	36.8	39.7	42.6	45.1	47.2	48.8	49.9	50.6	50.2	49.0	47.3	44.8	42.2	40.2	38.7	41.1	0.08	4.95
Kansas City	51.2	50.4	49.6	48.9	48.2	47.6	47.2	47.4	48.4	50.3	52.7	54.9	56.6	58.1	59.2	59.9	60.1	59.7	58.5	56.8	55.5	54.3	53.1	52.1	53.4	0.43	1.79
Key West	74.8	74.6	74.4	74.2	74.1	74.1	74.6	75.8	76.7	77.6	78.4	78.8	78.9	79.1	78.9	78.6	77.6	77.2	76.2	75.9	75.6	75.4	75.2	74.9	76.3	0.23	0.04
Marquette	38.8	38.5	38.2	37.8	37.4	37.3	37.6	38.5	30.5	40.7	42.0	43.0	47.1	44.2	44.3	44.2	43.8	43.0	42.2	41.2	40.3	39.7	39.4	39.0	40.6	0.37	1.28
Memphis	58.0	57.3	56.6	56.0	55.4	54.8	54.7	54.8	57.1	59.2	61.3	63.4	64.8	66.1	66.9	67.3	67.1	66.3	65.0	63.4	62.0	60.8	59.8	58.9	60.8	0.77	1.34
New Orleans	65.4	65.0	64.6	64.2	63.9	63.6	63.6	64.3	65.5	67.3	69.1	70.6	71.6	72.3	72.7	72.9	72.7	72.0	70.7	69.2	68.1	67.3	66.5	65.9	67.0	0.62	0.02
New York	49.6	49.1	48.6	48.2	47.9	47.7	48.1	49.1	50.4	51.9	53.5	54.8	55.9	56.5	56.8	56.7	56.0	55.2	54.1	53.1	52.3	51.6	50.8	50.2	52.0	1.64	0.14
Philadelphia	50.3	49.8	49.4	49.0	48.6	48.5	49.0	50.4	51.8	53.6	55.3	56.8	57.9	57.9	59.0	59.0	58.3	57.2	55.7	54.5	53.3	52.4	51.6	51.0	53.4	0.92	0.06
Pittsburg	50.1	49.4	48.7	48.1	47.7	47.4	47.8	49.1	50.9	53.0	55.0	56.6	57.8	58.5	58.9	59.0	58.5	57.6	56.4	55.2	53.9	52.8	51.8	51.0	53.1	0.64	1.51
Portland, Oreg.	51.1	50.2	49.2	48.5	47.8	47.2	46.6	46.3	46.3	46.8	47.8	49.2	51.0	52.7	54.5	55.8	56.9	57.5	57.6	57.2	56.1	54.9	53.4	52.2	51.5	1.12	0.09
St. Louis	53.4	52.6	51.9	51.2	50.6	50.1	49.9	50.5	51.7	53.6	55.7	57.7	59.2	60.5	61.4	61.8	61.7	61.0	59.9	58.6	57.4	56.2	55.2	54.3	55.7	0.60	0.94
St. Paul	41.4	40.6	39.8	39.1	38.4	37.8	37.5	38.2	39.3	41.2	43.5	45.6	47.4	48.7	49.7	50.2	50.4	49.9	48.9	47.5	46.0	44.7	43.5	42.5	43.8	0.63	1.52
Salt Lake City	48.5	47.8	47.0	46.3	45.8	45.2	44.7	44.7	45.1	47.0	49.8	52.5	54.7	56.3	57.2	57.9	58.1	58.0	57.2	55.8	54.1	52.0	50.6	49.4	51.1	0.46	8.56
San Diego	58.0	57.6	57.1	56.8	56.5	56.3	56.0	55.8	55.9	56.8	59.2	61.3	63.4	64.6	65.2	65.4	65.4	65.1	64.2	63.2	61.5	60.3	59.3	58.7	60.1	0.32	0.07
San Francisco	53.1	52.8	52.5	52.2	51.9	51.6	51.3	51.1	51.1	51.7	52.9	54.4	55.9	57.3	58.3	58.9	59.1	58.8	58.0	56.8	55.7	54.8	54.1	53.6	54.5	0.89	0.05
Savannah	62.0	61.4	60.9	60.5	60.0	59.7	60.2	61.9	64.5	67.1	69.4	71.1	72.1	72.6	72.4	71.5	70.1	68.3	66.5	65.2	64.3	63.7	63.1	62.5	65.5	0.35	0.11
Washington	50.5	50.0	49.4	48.9	48.4	48.3	49.0	51.0	53.1	55.3	57.2	58.9	60.1	61.0	61.4	61.3	60.4	59.0	57.1	55.3	53.9	53.0	52.0	51.2	54.4	0.32	0.16

nomena we are vitally interested. But as a simple manner of presenting statistics, and not as a method of studying any real atmospheric phenomenon, there can be no objection to the use of isotherms of temperature reduced to sea level, for which purpose a rate of increase or diminution, varying with the month of the year and the hour of the day, must be used, the average for the whole year being 2.0° F. per 1,000 feet from the standard ground to sea level. This reduction of annual means to sea level is given in the last column of Table 3. The sum of these last two columns gives the total reduction to sea level for mean annual temperatures.

When such reduced temperatures are plotted and isotherms drawn, the latter should be considered as simply a convenience by means of which one can ascertain the approximate temperature at the surface of the ground for any region where actual observations have not been made, to do which one interpolates from the map the isotherms for sea-level temperature and then applies a reduction of 2° of cooling per thousand feet of ascent.

Tables 3 and 6 give the hourly and monthly mean velocity of the wind. In the first of these tables, for instance, the figures 8.5 for Bismarck, indicate the average movement of the wind 8.5 miles during the hour from midnight to 1 o'clock, or, in general, during the hour ending with the moment of standard time inscribed at the head of the table. In this respect this table differs from Nos. 1 and 2, which give the pressure and temperature, respectively, at the exact moments of standard time inscribed at the head of the table.

As the anemometers, like the thermometers, are placed as high as possible above ground their records need a reduction to some standard elevation before they can become strictly comparable. But such a reduction will vary according to the nature of the surface beneath the anemometer, and even with the time of day and the season of the year. On the average of the year we may expect that the higher anemometers will show the greater velocities. The heights of the anemometers above ground are shown in the seventh column of Table 7, but, as most of these are located in cities, the

TABLE 3.—*Mean local wind velocity for each hour interval of seventy-fifth meridian time.*

Stations.	1 a.m.	2 a.m.	3 a.m.	4 a.m.	5 a.m.	6 a.m.	7 a.m.	8 a.m.	9 a.m.	10 a.m.	11 a.m.	Noon.	1 p.m.	2 p.m.	3 p.m.	4 p.m.	5 p.m.	6 p.m.	7 p.m.	8 p.m.	9 p.m.	10 p.m.	11 p.m.	Midnight.	Daily mean.	Reduced to 20 feet.
Bismarck	8.5	8.4	8.2	8.1	8.2	8.2	8.0	8.2	8.7	9.5	10.7	10.8	12.9	13.7	14.0	14.0	13.7	13.1	11.9	10.8	9.7	9.2	8.9	8.8	10.3	11.3
Boston	10.6	10.3	10.2	10.1	10.1	10.2	10.4	10.7	11.4	12.0	12.5	13.0	13.3	13.4	13.5	13.3	12.7	12.1	11.5	11.1	11.2	11.0	10.8	10.8	11.5	6.3
Buffalo	10.4	10.2	10.2	10.2	10.2	10.2	10.5	10.6	11.2	11.8	12.3	12.8	13.2	13.3	13.4	13.1	12.6	12.3	11.7	11.0	10.6	10.5	10.4	10.4	11.4	8.0
Chicago	17.1	16.8	16.9	16.9	16.9	16.9	17.0	16.5	16.6	16.9	17.2	17.6	18.2	18.1	18.6	18.6	18.4	17.9	17.4	16.7	16.7	16.8	16.9	17.0	17.3	8.0
Cincinnati	5.7	5.6	5.4	5.4	5.4	5.4	5.5	6.0	7.0	7.7	8.4	8.8	9.3	9.4	9.4	9.4	9.1	8.7	7.8	6.9	6.5	6.2	6.0	5.9	7.1	4.1
Cleveland	11.4	11.5	11.4	11.4	11.4	11.3	11.3	11.4	11.8	12.3	12.9	13.2	13.6	13.7	13.6	13.2	12.5	11.6	10.7	10.4	10.6	11.0	11.2	11.3	11.9	7.1
Detroit	9.7	9.5	9.5	9.4	9.4	9.7	9.6	9.8	10.3	11.2	11.8	12.7	13.0	13.2	13.4	13.2	12.6	12.1	10.8	10.2	10.0	9.9	9.9	10.0	10.9	6.2
Dodge City	10.6	10.4	10.3	10.2	9.9	9.7	9.5	9.5	10.5	12.1	13.6	14.3	14.5	14.8	15.1	15.1	14.9	14.5	13.5	12.1	10.9	10.8	10.8	10.8	12.0	10.8
Eastport	9.4	9.2	9.2	9.3	9.3	9.6	9.6	10.0	10.5	11.0	11.3	11.7	11.6	11.8	11.7	11.4	10.9	10.5	9.9	9.8	9.8	9.7	9.5	9.7	10.3	8.2
Galveston	11.1	11.0	11.0	10.7	10.6	10.5	10.4	10.4	10.9	11.3	11.6	11.7	12.0	11.9	12.0	12.0	11.9	11.7	11.2	10.9	10.9	11.0	11.0	11.0	11.2	7.8
Havre	8.3	8.3	8.2	8.3	8.4	8.5	8.4	8.4	8.7	9.4	10.3	11.0	11.9	12.3	12.7	12.8	12.6	11.9	11.1	10.4	9.5	8.7	8.5	8.4	9.9	10.1
Kansas City	7.9	7.7	7.6	7.7	7.6	7.5	7.7	7.8	8.4	9.0	9.7	10.0	10.6	10.4	10.6	10.6	10.4	9.8	9.0	8.1	7.8	7.9	8.0	7.9	8.8	6.2
Key West	9.2	9.3	9.1	8.9	8.9	8.8	8.8	9.4	10.0	10.4	10.7	10.8	10.8	10.9	10.8	10.5	10.4	9.9	9.6	9.6	9.7	9.6	9.6	9.4	9.8	8.8
Marquette	9.9	10.0	10.0	9.9	9.9	9.7	9.6	9.8	10.3	10.8	11.2	11.5	11.7	11.8	11.6	11.2	10.6	9.8	9.0	8.6	8.6	9.0	9.5	9.8	10.2	7.1
Memphis	6.8	6.6	6.6	6.5	6.5	6.4	6.5	6.6	7.2	7.8	8.1	8.3	8.7	8.5	8.7	8.7	8.5	8.1	7.4	6.5	6.4	6.5	6.6	6.8	7.3	4.1
New Orleans	7.4	7.3	7.2	7.1	7.0	7.0	7.1	7.3	8.3	9.3	9.8	10.1	10.6	10.6	10.7	10.7	10.3	9.7	8.8	8.0	7.8	7.7	7.6	7.6	8.5	5.1
New York	10.4	10.1	10.0	9.9	10.0	10.1	10.1	10.4	11.0	11.4	11.8	12.1	12.4	12.6	12.9	12.9	12.8	12.3	11.7	11.3	11.2	12.0	10.8	10.6	11.2	4.9
Philadelphia	9.2	9.0	9.0	9.0	9.0	9.0	9.3	10.0	10.7	11.3	11.7	11.9	12.3	12.5	12.5	12.4	12.0	11.3	10.6	10.1	10.0	9.7	9.5	9.3	10.5	5.8
Pittsburg	5.4	5.2	5.1	5.1	5.1	5.1	5.3	5.7	6.3	7.0	7.6	7.8	8.3	8.3	8.4	8.3	8.0	7.5	6.8	6.3	6.0	5.8	5.7	5.5	6.5	3.9
Portland, Oreg.	7.5	7.2	7.0	6.6	6.5	6.4	6.3	6.3	6.2	6.4	6.9	7.4	8.0	8.1	8.3	8.6	8.7	8.8	8.8	8.6	8.3	8.0	7.7	7.6	7.5	3.8
St. Louis	10.5	10.2	10.2	10.0	9.9	9.9	9.8	10.0	10.6	11.2	11.6	12.0	12.4	12.6	12.9	13.0	13.0	12.6	11.8	11.0	10.8	10.7	10.7	10.7	11.2	5.6
St. Paul	6.5	6.2	6.1	6.1	6.1	6.2	6.3	6.3	6.8	7.6	8.4	9.2	9.7	9.7	9.9	9.9	9.6	9.2	8.4	7.5	6.9	6.7	6.6	6.6	7.6	4.6
Salt Lake City	4.6	4.6	4.5	4.4	4.3	4.4	4.3	4.3	4.2	4.2	4.6	5.6	6.9	7.9	8.8	9.1	9.2	8.9	7.9	6.8	5.7	5.0	5.0	4.9	5.8	4.1
San Diego	3.1	3.0	3.0	3.0	3.1	3.2	3.1	3.2	3.2	3.2	3.4	3.9	5.4	6.8	8.0	8.8	9.0	8.9	8.3	7.2	5.9	4.6	3.8	3.4	5.0	4.0
San Francisco	9.1	8.3	7.8	7.4	7.1	6.8	6.6	6.6	6.5	6.5	6.9	7.5	8.3	9.3	11.0	12.7	14.3	15.5	15.7	15.6	14.9	13.4	11.8	10.8	10.0	5.7
Santa Fe	6.3	6.2	5.8	5.5	5.3	5.1	5.0	5.0	5.0	5.6	6.8	7.9	8.8	9.6	10.1	10.4	10.3	10.1	9.4	8.3	7.2	6.6	6.6	6.7	7.2	6.5
Savannah	6.6	6.3	6.4	6.4	6.4	6.5	6.6	6.9	7.6	8.2	8.8	9.2	9.6	10.0	10.3	10.5	10.2	9.5	8.2	7.3	7.1	6.9	6.8	6.9	7.9	6.3
Washington	5.1	5.0	4.9	4.9	4.9	4.9	5.1	5.8	6.8	7.9	8.6	9.0	9.5	9.6	9.6	9.3	8.6	7.5	6.6	5.8	5.6	5.4	5.3	5.2	6.7	5.4

TABLE 4.—*Average pressure.*

Stations.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
Bismarck	.214	.239	.197	.156	.175	.121	.203	.195	.137	.186	.193	.159	28.181
Boston	.878	.901	.869	.872	.839	.856	.842	.848	.951	.874	.953	.931	29.884
Buffalo	.235	.290	.274	.266	.219	.247	.260	.252	.325	.264	.295	.302	29.269
Chicago	.183	.178	.131	.103	.098	.105	.153	.135	.174	.148	.166	.158	29.140
Cincinnati	.407	.444	.386	.349	.333	.340	.379	.345	.423	.414	.450	.462	29.394
Cleveland	.221	.272	.242	.224	.190	.212	.241	.221	.287	.243	.269	.282	29.242
Detroit	.219	.273	.247	.229	.195	.217	.246	.230	.292	.248	.268	.273	29.245
Dodge City	.418	.427	.356	.314	.345	.348	.424	.425	.406	.444	.440	.423	27.398
Eastport	.875	.879	.852	.874	.869	.881	.845	.863	.949	.870	.954	.909	29.885
Galveston*	.092	.096	.047	.978	.950	.979	.030	.982	.988	.035	.118	.142	30.036
Havre	.345	.353	.301	.296	.313	.289	.353	.358	.301	.357	.328	.288	27.324
Key West	.110	.120	.090	.062	.009	.018	.078	.015	.976	.949	.071	.124	30.052
Marquette	.130	.215	.172	.192	.126	.138	.168	.181	.155	.122	.172	.154	29.160
Memphis	.719	.732	.664	.608	.600	.590	.635	.602	.660	.695	.736	.750	29.666
New Orleans	.082	.075	.035	.996	.968	.954	.009	.958	.969	.017	.101	.124	30.024
New York	.711	.752	.712	.702	.655	.679	.675	.666	.773	.707	.784	.783	29.717
Philadelphia	.940	.979	.935	.920	.869	.887	.889	.875	.986	.930	.008	.016	29.936
Pittsburg	.134*	.176	.144	.131	.100	.125	.147	.124	.206	.164	.202	.213	29.156
Portland, Oreg	.935	.897	.849	.898	.863	.891	.898	.852	.843	.904	.953	.927	29.892
St. Louis	.485	.515	.432	.374	.377	.375	.432	.408	.444	.478	.503	.500	29.444
St. Paul	.136	.161	.104	.049	.050	.038	.102	.094	.071	.078	.124	.091	29.091
Salt Lake City	.720	.662	.598	.621	.594	.604	.663	.666	.643	.724	.745	.733	25.664
San Diego	.008	.002	.972	.969	.909	.867	.878	.859	.854	.913	.985	.048	29.939
San Francisco	.972	.948	.917	.957	.849	.836	.826	.803	.823	.889	.958	.015	29.899
Santa Fe	.217	.193	.177	.220	.261	.310	.415	.411	.377	.353	.299	.250	23.290
Savannah	.035	.052	.000	.985	.934	.945	.979	.923	.972	.964	.063	.091	29.995
Washington, D.C.	.966	.006	.958	.936	.883	.901	.911	.892	.999	.956	.032	.042	29.957

*Means for four years.

TABLE 5.—*Average temperature.*

Stations.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
Bismarck	9.6	7.2	23.7*	42.0*	52.9	63.2	69.5	68.6	59.7	44.3	24.4	15.8	40.1
Boston	28.0	27.9	35.3	46.3	56.3	66.4	70.6	69.2	63.5	52.2	41.6	33.7	49.2
Buffalo	25.0	24.5	31.9	43.6	54.0	67.1	69.4	69.1	64.3	51.8	38.8*	32.4	47.7
Chicago	21.9	24.4	33.6	45.7	54.7	67.6	71.1	70.8	66.5	51.6	35.4	29.6	47.7
Cincinnati	29.8	33.9	41.7	54.8	62.2	74.7	76.0	75.5	70.6	55.5	42.2	37.4	54.5
Cleveland	25.7	27.5	34.2	47.3	56.6	69.4	71.1	69.9	65.9	52.1	39.2	33.3	49.4
Detroit	23.2	24.7	32.5	46.3	56.2	69.6	71.2	70.1	65.0	50.3	36.7	30.6	48.0
Dodge City	28.5	28.5	39.8	55.4	62.0	72.0	76.4	74.9	69.8	55.4	40.8	32.5	53.0
Eastport	22.5	22.0	29.6	39.0	47.1	54.1	59.5	60.2	55.8	47.0	38.1	28.0	41.9
Galveston	53.4	54.7	60.4	69.4	74.8	79.9	82.5	81.7	79.9	72.2	63.4	57.9	69.2
Havre	15.0	10.9	25.8	43.6	52.6	59.8	68.1	66.9	55.3	44.3	28.7	21.9	41.1
Kansas City	24.9	29.1	40.2	55.9	62.6	73.4	75.7	75.3	70.8	57.2	40.8	34.4	53.4
Key West	68.0	69.7	72.3	75.3	78.5	81.1	83.1	83.5	82.3	77.9	73.7	70.5	76.3
Marquette	14.2	14.3	24.8	37.1	47.9	61.6	66.1	63.4	59.0	45.7	30.7	22.4	40.6
Memphis	39.7	43.3	50.9	63.3	68.4	77.7	78.2	77.9	73.7	61.4	50.4	44.8	60.8
New Orleans	51.9	56.3	60.6	68.9	74.3	79.1	80.2	80.3	78.3	68.8	50.1	55.8	67.0
New York	30.3	30.9	37.4	49.0	59.1	69.7	73.0	73.1	67.5	54.6	43.4	36.0	52.0
Philadelphia	31.4	32.6	39.2	51.2	61.2	72.1	74.3	74.1	68.3	55.2	43.8	37.0	53.4
Pittsburg	30.3	32.6	39.5	52.3	61.3	72.9	73.2	73.1	68.5	54.0	42.6	37.1	53.1
Portland, Oreg	38.6	39.0	44.9	48.9	56.3	59.5	65.6	67.2	59.1	52.7	46.1	40.5	51.5
St. Louis	29.8	32.9	43.4	57.2	64.4	76.5	77.3	76.9	72.0	57.5	42.5	37.6	55.7
St. Paul	10.8	13.9	27.9	46.1	56.3	68.2	71.7	69.6	63.5	47.9	28.7	21.2	43.8
Salt Lake City	27.9	29.5	40.6	49.2	58.8	65.7	75.5	75.8	64.9	53.2	41.7	30.1	51.1
San Diego	53.7	54.0	55.1	57.6	60.7	62.8	66.2	68.6	66.7	63.2	58.5	54.5	60.1
San Francisco	49.1	50.6	51.7	52.8	55.6	56.3	56.5	57.6	59.7	57.4	56.5	50.3	54.5
Savannah	49.1	53.3	57.7	65.5	71.4	77.6	79.3	79.6	76.0	66.0	57.0	53.1	65.5
Washington, D. C.	32.5	34.9	41.3	53.5	62.8	73.2	74.5	74.7	68.7	54.7	44.2	37.8	54.4

*Means for 4 years.

ground from which the measurements are made is far below the average roofs of the surrounding buildings. Even in the smaller towns, the open country, and the prairie the anemometer may be considered as being slightly affected by trees, buildings, and inevitable irregularities in the surface of the ground. As a crude approximation, we will assume that the velocity increases as the 0.4 power of one-half the altitude above ground. Under this assumption the standard velocity for 20 feet is given by the formula

$$\frac{v}{V}=\left(\frac{40}{H}\right)^{0.4}$$

The exponent 0.5 would be appropriate for smaller altitudes, and 0.3 for much larger ones, but 0.4 is appropriate for values of H between 40 and 400 feet, and gives us the following table of factors by which the upper velocity V is to be multiplied in order to obtain the velocity at 20 feet:

H	Factor.	H	Factor.
Feet.		*Feet.*	
40	1.000	240	0.488
80	0.758	280	0.459
120	0.644	320	0.435
160	0.574	360	0.415
200	0.525	400	0.398

The special factors for our stations are given in Table 7.

Using these factors we obtain the reduced velocities given in the last column of Table 3. Crude as this reduction is it serves to reduce to a fair degree of uniformity the records of coastal and interior stations and brings out, for instance, with considerable prominence the strong winds at Havre, Dodge City, and Bismarck.

The velocities given in these tables are measurements made with the standard anemometers of the Weather Bureau, these are of the Robinson type, and, according to the investi-

TABLE 6.—*Wind velocity, monthly and annual means.*

Stations.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
Bismarck	9.8	10.0	10.6	13.3	11.8	10.6	9.2	8.9	10.5	10.4	10.2	8.9	10.8
Boston	12.1	13.2	13.7	12.3	11.4	10.2	9.8	9.7	9.9	11.6	11.8	12.5	11.5
Buffalo	13.8	13.6	12.5	10.5	9.6	8.4	9.4	8.1	9.7	12.1	13.9	15.0	11.4
Chicago	17.7	19.3	20.1	18.9	17.6	14.0	14.0	13.8	16.7	17.4	18.4	19.4	17.3
Cincinnati	8.0	8.8	8.8	7.7	6.9	5.7	6.0	5.5	5.8	6.7	7.9	7.6	7.1
Cleveland	12.3	13.3	12.5	11.3	11.2	9.5	9.5	9.4	11.7	13.0	14.6	14.2	11.9
Detroit	11.3	12.6	12.2	11.7	10.4	8.9	8.9	8.1	9.8	11.3	12.5	12.7	10.9
Dodge City	9.9	11.0	13.4	15.0	13.5	14.0	11.8	10.4	13.0	10.8	10.7	10.6	12.0
Eastport	13.1	13.5	12.4	10.8	8.9	7.3	6.6	6.9	8.2	10.6	12.2	12.6	10.3
Galveston	11.8	12.6	12.7	12.2	12.1	10.4	9.8	8.3	10.3	10.5	11.4	12.2	11.2
Havre	10.8	10.0	10.3	10.8	10.1	9.4	8.1	7.5	9.6	9.2	11.0	11.7	9.9
Kansas City	8.7	9.6	11.1	9.8	8.5	7.5	7.3	6.6	8.4	8.4	9.4	9.7	8.8
Key West	10.7	11.3	10.8	10.5	8.8	7.3	7.4	6.7	8.0	12.6	11.7	11.9	9.8
Marquette	10.0	10.2	10.1	9.7	10.4	8.2	8.6	8.9	11.4	11.7	11.3	11.4	10.2
Memphis	7.9	8.7	8.7	8.2	7.3	5.7	5.7	5.7	6.1	6.7	8.2	8.8	7.3
New Orleans	9.2	10.4	10.3	9.7	8.3	7.0	6.4	6.3	7.6	8.7	8.8	9.6	8.5
New York	11.7	13.1	13.4	12.2	11.1	9.1	9.2	8.7	9.5	12.0	12.2	12.7	11.2
Philadelphia	11.1	12.6	12.4	11.4	10.3	9.3	9.1	8.5	9.1	10.5	10.7	10.7	10.5
Pittsburg	7.3	7.6	7.6	7.0	6.1	5.6	5.2	5.0	5.6	6.2	7.4	7.2	6.5
Portland, Oreg.	7.0	7.5	7.7	8.1	7.6	7.1	7.2	6.8	6.9	7.3	8.0	8.9	7.5
St. Louis	12.3	12.4	13.7	12.2	11.4	9.4	9.3	8.2	9.4	10.8	12.2	12.7	11.2
St. Paul	7.4	8.0	8.2	8.9	8.1	7.4	6.5	6.1	7.7	7.9	8.0	7.4	7.6
Salt Lake City	4.6	5.2	6.5	6.7	6.7	6.4	5.9	5.7	6.6	5.3	5.3	5.2	5.8
San Diego	4.5	5.2	5.5	5.3	5.7	5.3	5.0	4.8	5.0	4.4	4.2	4.5	5.0
San Francisco	7.3	7.9	9.2	10.6	11.5	13.3	13.9	12.6	10.9	8.2	6.8	7.6	10.0
Santa Fe	6.8	7.1	8.2	8.7	8.3	8.2	6.9	6.2	6.5	6.8	6.6	6.9	7.2
Savannah	8.4	9.3	8.8	9.0	8.1	7.3	6.9	6.4	6.9	8.3	7.6	7.6	7.9
Washington, D. C.	7.2	8.6	8.6	8.2	6.8	5.6	5.2	4.9	5.2	6.5	7.1	6.5	6.7

gations of Professor Marvin, the indicated velocities of the wind need a considerable reduction in order to obtain the true velocities in standard miles per hour. The error of the Robinson anemometer increases with the gustiness of the wind; the influence of gusts can not be determined *a priori* in detail as they vary their nature so rapidly; it can be determined approximately by comparing the records of anemometers of the same type, but very different moments of inertia. For steady winds, viz, without any very decided gustiness, the indications of the anemometer may be converted into true velocities by a study of the experiments with anemometers revolved on large whirling machines. For the Weather Bureau anemometers having hemispherical cups 4 inches in diameter, and whose centers describe circles of 6.72 inches radius, and after applying a correction for the effect of the average degree of gustiness at Washington, D. C., Professor Marvin deduced the following reduction table by means of which the above indicated velocities at Weather Bureau stations may be converted into approximate true velocities:

Conversion of indicated velocities of winds of average gustiness into true velocities.

(The argument is indicated velocities in miles per hour.)

	0	1	2	3	4	5	6	7	8	9
0	......	......	......	......	......	5.1	6.0	6.9	7.8	8.7
10	9.6	10.4	11.3	12.1	12.9	13.8	14.6	15.4	16.2	17.0
20	17.8	18.6	19.4	20.2	21.0	21.8	22.6	23.4	24.2	24.9
30	25.7	26.5	27.3	28.0	28.8	29.6	30.3	31.1	31.8	32.6
40	33.3	34.1	34.8	35.6	36.3	37.1	37.8	38.5	39.3	40.0
50	40.8	41.5	42.2	43.0	43.7	44.4	45.1	45.9	46.6	47.3
60*	48.0	......	......	......	......	......	......	......	......	......

* For velocities above 60 indicated, the necessary observations are still wanting.

For velocities less than 6 miles so much depends upon the condition of the anemometer, as to whether it is well oiled and otherwise in perfect condition, that a table of conversion would have but little significance in daily practice. In general, however, the indicated velocities would be too small; whereas above 6 miles they are too large.

As the corrected figures are not simple multiples of the indicated velocities, but rather logarithmic functions, it follows that when we convert the average of two or more indicated velocities, we obtain a different result from what would be given if the observations were individually converted before the average is taken. In consequence of this, the true velocities obtained by converting the averages given in Table 3 will be appreciably larger than if the conversion had been carried out for each individual velocity before taking the average. As extreme a case as is likely to happen would be that of taking the average of two indicated velocities of 60 and 5 miles per hour, respectively. The average before the conversion is 32.5, which corresponds to 27.6 true velocity. The average after conversion is the average of 48.0 and 5.1, which is 26.55, or 1 mile per hour less than in the previous result. Of course the uncertainty of the true velocities introduced by converting the averages given in Table 3 is far less than 1 mile per hour, and depends principally upon the average condition of the anemometer and the average gustiness of the wind.

TABLE 7.—*Station data for December* 31, 1895.

Stations.	Longitude.	Local time.	Latitude north.	Above ground. Thermometer.	Above ground. Anemometer.	Above ground. Rain gauge.	Above sea. Ground.	Above sea. Barometer.	Above sea. Thermometer.	Computed gravity. Sea level.	Computed gravity. Station level.	Computed gravity. Relative to standard.	Reduction of wind to 30 feet.
	° ′	h. m.	° ′	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Dynes.	Dynes.		Factor.
Bismarck	100 38	6 18	46 47	16	29	3	1,670	1,681	1,686	980.759	980.601	1.000004	1.1
Boston	71 04	8 16	42 21	115	181	154	16	125	131	980.356	980.345	0.999743	0.55
Buffalo	78 53	7 45	42 53	103	108	98	606	690	709	980.404	980.340	0.999738	0.7
Chicago	87 37	7 10	41 83	241	274	288	597	824	838	980.314	980.238	0.999634	0.46
Cincinnati	84 30	7 22	39 06	153	157	145	553	628	706	980.065	980.005	0.999396	0.57
Cleveland	81 42	7 33	41 30	122	130	109	649	740	771	980.280	980.211	0.999606	0.6
Detroit	83 03	7 28	42 20	158	161	144	599	724	757	980.354	980.287	0.999684	0.57
Dodge City	100 00	6 20	37 45	44	52	37	2,485	2,504	2,529	979.946	979.712	0.999097	0.9
Eastport	66 59	8 32	44 54	69	74	63	33	76	107	980.588	980.580	0.999983	0.8
Galveston	94 50	6 41	29 18	85	96	80	5	42	90	979.243	979.232	0.998608	0.7
Havre	109 40	5 41	48 34	15	33	2	2,477	2,477	2,492	980.919	980.687	1.000091	1.1
Kansas City	94 37	6 42	39 05	78	95	81	896	963	974	980.063	979.973	0.999364	0.7
Key West	81 49	7 33	24 34	42	50	44	22	22	64	978.967	978.965	0.998335	0.9
Marquette	87 24	7 11	46 34	67	95	58	641	734	708	980.739	980.671	1.000075	0.7
Memphis	90 03	7 00	35 09	140	154	134	672	399	812	979.722	979.684	0.999069	0.57
New Orleans	90 04	7 00	29 58	112	120	111	9	54	121	979.295	979.290	0.998667	0.6
New York	74 00	8 04	40 43	298	326	347	68	314	766	980.210	980.180	0.999575	0.44
Philadelphia	75 09	8 00	39 59	168	184	166	42	117	210	980.140	980.129	0.999523	0.55
Pittsburg	80 02	7 40	40 32	116	123	101	756	842	872	980.189	980.111	0.999504	0.6
Portland, Oreg.	122 43	4 49	45 32	203	213	196	43	157	246	980.645	980.631	1.000035	0.50
St. Louis	90 12	6 59	38 38	110	210	100	469	571	579	980.025	979.972	0.999362	0.50
St. Paul	93 03	6 48	44 58	114	124	93	759	850	873	980.594	980.515	0.999916	0.6
Salt Lake City	111 54	5 33	40 46	83	90	75	4,282	4,345	4,365	980.215	979.809	0.999296	0.7
San Diego	117 10	5 11	32 43	59	70	52	36	69	95	979.517	979.511	0.998892	0.8
San Francisco	122 26	4 50	37 48	161	167	154	26	153	187	979.952	979.968	0.999328	0.57
Santa Fe	105 57	5 56	35 41	47	50	39	6,966	6,998	7,013	979.767	979.112	0.998485	0.9
Savannah	81 05	7 36	32 05	63	86	55	56	98	119	979.465	979.456	0.998836	0.8
Washington, D. C.	77 03	7 52	38 54	49	76	42	80	112	179	980.047	980.037	0.999429	0.8